INFORMATION SHEET FOR THE FY2022 NOAA/OAR/WPO SUBSEASONAL-TO-SEASONAL (S2S) COMPETITION

The Weather Research and Forecasting Innovation Act of 2017 calls for NOAA to improve its Subseasonal to Seasonal (S2S) capabilities, and defines subseasonal to seasonal as the range between two weeks and two years. NOAA's Office of Oceanic and Atmospheric Research (OAR) is aligning its subseasonal to seasonal research with other observational and weather research within the Weather Program Office to efficiently support the Weather Act goals. Through this effort, NOAA and OAR will address a spectrum of issues on the subseasonal to seasonal time frame ranging from foundational research to the transition of research to operations.

NOAA is moving toward a unified modeling approach to support prediction of extreme weather and its associated drivers at extended time ranges. A key aim is to harness predictability sources across scales present in the Earth system relevant to the subseasonal to seasonal prediction problem, from the synoptic range out to two years. Such predictability sources include cyclical modes of variability (i.e. MJO, ENSO, NAO, QBO, etc.) as well as their interactions and impacts on extremes and high-impact weather.

The WPO S2S program will support the progression of NOAA's ability to address these challenges. In particular, the program will place a strong emphasis on projects designed to increase capabilities related to precipitation, its excess, shortfalls, duration, and precision of spatial and temporal placement on the subseasonal to seasonal scale. A myriad of factors known and unknown contribute to accurate prediction of precipitation or drought beyond two weeks. Additional factors such as vegetation or fuel development exacerbating fire weather precursors are of interest. While projects investigating any of these factors will be considered, preference will be given to proposals that utilize models and components participating in NOAA's Unified Forecast System (UFS) and ongoing multi-model ensemble efforts on the subseasonal to seasonal timescale within the North American Multi-Model Ensemble (NMME) or its related subseasonal ensemble effort, and which leverage existing NOAA, WMO, and other agency datasets. Projects should address improvements in the three areas of immediate need detailed below - data assimilation, numerical model processes and component interaction via the community-based UFS, and multi-model ensemble methods and postprocessing.

1. Improved data assimilation (DA) for individual Earth system components such as the cryosphere, ocean, waves, land surface, and atmospheric composition and the incorporation of new observation types is critical to better monitoring Earth system variability across all time scales. Coupled DA, where observations in one component of the Earth system are allowed to directly impact the state estimation in other components, is crucial to advance subseasonal-to-seasonal prediction through improved model initialization, in particular within the community-based Join Effort for DA Integration (JEDI) project. The optimum approach(es) to coupled DA in the context of Earth system modeling and prediction is an open research question, and thus represents a major research need for NOAA. Projects supporting improved DA will:

    - develop a new methodology, or significantly advance an existing methodology, for coupled DA with demonstrable relevance to the Earth system prediction and/or monitoring needs on the subseasonal to seasonal scale of one or more

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- develop new or experimental DA-based approaches to monitoring products for the cryosphere, ocean, land surface, or atmospheric composition on the subseasonal to seasonal scale;
- emphasize the implications and application of these technologies on prediction of precipitation on the subseasonal to seasonal scale while utilizing existing NOAA, WMO, and other agency datasets.

2. To improve model capabilities, it is crucial to identify and address sources of model bias across NOAA's modeling suite. This involves understanding the source of the biases such as issues in models' physical process representation, model component interaction, numerical approach, or the interactions between these issues, via a systematic process-oriented evaluation of the biases. The WPO S2S effort is interested in supporting community-based approaches to improve Earth system models via development and evaluation of individual sub-elements within model components (e.g. the surface drag parameterization in a surface-layer turbulence scheme or ocean mixed layer thermohaline processes), single column modeling, limited area modeling, and more. Development and evaluation may extend to or focus on processes occurring within one component of the Earth system models or on characterizing the component-to-component interactions, i.e., land-atmosphere, ocean-atmosphere, ocean-ice flux exchanges. Evaluations should include the interactions of such sub-elements or processes, with all those model parts progressively connected/coupled in a hierarchy that culminates in a global Earth system model (that could include atmosphere/aerosols/chemistry, ocean/sea-ice/waves, and land-hydrology/land-ice earth system components). Efforts towards building tools for process oriented diagnostics to assess earth system model component performance or inter-model interactions are invited. Fundamental research may also address attribution, implicit model bias, and progression of models participating in community ensembles that contribute to the predictive capability. This predictive capability focus should emphasize a range of phenomena related to precipitation/drought, processes influencing precipitation/drought, and implications of modeled precipitation or its lack for forecast utility. The portfolio will only consider models and components designed to improve or supplement the community-based NOAA Unified Forecast System development.

3. To improve ensemble prediction capabilities, including multi-model ensembles, the WPO S2S program is interested in proposals improving existing ensembles, via techniques to determine the optimal number of models vs. number of members for each Earth System model, leading to improved prediction skill and assessments of uncertainty for various phenomena (e.g., temperature, precipitation, snowpack, sea ice conditions, extreme and high-impact weather to include conditions contributing to droughts, fires, tornadoes, hurricanes, floods, heat waves, coastal inundation, and winter storms) with a specific emphasis on subseasonal to seasonal precipitation. Sophisticated ensemble methodologies might utilize various statistical regression, error reduction, and bias correction schema while incorporating other advanced, modern reanalysis and postprocessing techniques within the NMME or its related subseasonal ensemble effort.

Selected projects will be expected to participate in an annual workshop for the duration of the project, and share results with other researchers via webinars. Projects are expected to initially fall within Readiness Levels (RLs) 2 and 4. Formal transition plans are not required for projects within this program call unless the project expects to progress to RL 5 or greater by the end of the period of performance; however, investigators should describe the general transition process intended for their work to the UFS community model to be incorporated into the NOAA predictive capability. If the project has potential to progress beyond an RL of 4 at any point, per NAO 216-105B, the PI is required to submit a research-to-operations transition plan with the first progress report.

These funding opportunities are only open to non-Federal principal investigators; however, principal investigators are encouraged to consult with and include NOAA and/or other Federal employees as co-investigators.